Journal of Experimental Psychology: General
2008, Vol. 137, No. 2, 262–281

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0096-3445/08/$12.00 DOI: 10.1037/0096-3445.137.2.262

When Do Motor Behaviors (Mis)Match Affective Stimuli? An Evaluative Coding View of Approach and Avoidance Reactions

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Affective-mapping effects between affective stimuli and lever movements are critically dependent upon the evaluative meaning of the response labels that are used in the task instructions. In Experiments 1 and 2, affective-mapping effects predicted by specific-muscle-activation and distance-regulation accounts were replicated when the standard response labels *towards* and *away* were used but were reversed when identical lever movements were labeled *downwards* and *upwards*. In Experiment 3, affective-mapping effects were produced with affectively labeled right and left lever movements that are intrinsically unrelated to approach and avoidance. Experiments 4 and 5 revealed that affective-mapping effects are not mediated by memory retrieval processes and depend on the execution of affectively coded responses. The results support the assumption that evaluative implications of action instructions assign affective codes to motor responses on a representational level that interact with stimulus evaluations on a response selection stage.

Keywords: approach and avoidance, affective S-R compatibility, evaluative response coding

Many emotion theories associate emotions with primitive behavioral tendencies of approach and avoidance: Humans and simple organisms alike are believed to spontaneously approach positively evaluated, attractive stimuli and to avoid negatively appraised, aversive stimuli and events (e.g., Cacioppo, Larsen, Smith, & Berntson, 2004; Gray, 1987; Konorski, 1967; Schneirla, 1959; Watson, Wiese, Vaidya, & Tellegen, 1999). This emotional motor organization is typically assumed to reflect automatic processes of behavior regulation that are governed by activation states of respective defensive and appetitive motivational circuits (Dickinson & Dearing, 1979; Lang, Bradley, & Cuthbert, 1990; Neumann, Förster, & Strack, 2003; Sutton & Davidson, 1997). The functionality of a direct motivational control of approach and avoidance behavior that is unburdened by a time-consuming, deliberate, response-selection stage is intuitively plausible if one accepts the notion that emotions concern serious events demanding urgent responses (Frijda, 1986; Tooby & Cosmides, 1990). In support of this functional argument, approach and avoidance tendencies were shown to influence reactions towards biologically significant stimuli (e.g., Bradley, Codispoti, Cuthbert, & Lang, 2001; Marsh, Ambady, & Kleck, 2005), and also more complex areas of behaviors like self-control (e.g., Fishbach & Shah, 2006), social behavior (e.g., Castelli, Zogmaister, Smith, & Arcuri, 2004; Neumann, Hülsenbeck, & Seibt, 2004), consumer decisions (e.g., Förster, 2003) and disorder-related behaviors (e.g., Mogg, Bradley, Field, & De Houwer, 2003; Rinck & Becker, 2007).

This article critically discusses different conceptualizations of approach and avoidance reactions that were proposed to account for a match or mismatch between affective stimuli and specific motor reactions. In a discussion of valence modulations of lever pulls and pushes, we make the case that different construals of approach and avoidance frequently cause inconsistencies regarding which specific motor responses manifest approach and avoidance. These inconsistencies are resolved with an evaluative-response-coding view that proposes that mental representations of approach and avoidance go along with evaluative codings of these behaviors that match or mismatch the valence of the stimuli reacted to. A series of experiments showed that standard affective-mapping effects between affective stimuli and lever movements are replicated when the standard response labels *towards* and *away* are used but are reversed when response labels of opposite valence (*downwards* and *upwards*) are used in the instructions of these movements. These results support the assumption that evaluative implications of action instructions and action goals assign affective codes to motor responses on a representational level that interact with stimulus evaluations on a response selection stage. The evaluative response-coding framework is introduced as a unitary account of affective-mapping effects that is able to integrate previous findings in support of more exclusive theoretical models of approach and avoidance responses. Its theoretical focus on affective stimulus-response (S-R) compatibility principles, however, contrasts with a theoretical inference of motivational states from affective-mapping effects; instead, automatic influences on selection processes between positively and negatively coded responses are attributed to a correspondence relation between evaluative stimulus and response codes that sufficiently explains why particular motor reactions are emitted more efficiently to affective stimuli than others.

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We thank Jan De Houwer for helpful comments on an earlier version of this article and Susanne Augst, Anita Pälchen, Nora Kroska, Jonas Müller, and Franziska Meissner for their help in data collection.

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Defining Approach and Avoidance Reactions

Empirical evidence for an automatic link between affective stimuli and behavioral dispositions of approach and avoidance primarily originates from paradigms that show a better performance with positive–approach and negative–avoid assignments (congruent S-R pairing) than with negative–approach and positive–avoid pairings (incongruent S-R pairing). However, these studies hinge upon assumptions regarding which specific motor responses manifest approach and avoidance. In fact, several approaches to this definitional problem have been proposed in the literature so that a broad consensus in the conceptualization of approach and avoidance reactions is currently lacking.

One operationalization is to classify behavioral responses into appetitive and protective–defensive ones on the basis of their presumed biological function (Konorski, 1967). Drawing on such a reflex classification system, Lang and colleagues (e.g., Lang et al., 1990) accrued much evidence for an amplification of the defensive startle reflex during negative picture viewing. Findings of emotional reflex modulations (e.g., Bradley et al., 2001; Hillman, Rosengren, & Smith, 2004; Rhudy, Williams, McCabe, Nguyên, & Rambo, 2005), however, are restricted to the behavioral responses covered in the classification system (i.e., to exteroceptive reflexes) that should not be confused with more complex instrumental approach and avoidance behavior (e.g., hiding from a predator or smashing a vase upon the unfaithful lover; cf. Caro, 2005; Ekman, Friesen, & Simons, 1985; Frijda, 2004).

The latter type of instrumental action is more adequately addressed in studies that demand the execution of simple (manual) actions in processing tasks of affective stimuli. In a seminal study by Solarz (1960), for example, participants were to classify the evaluative meaning of words with pull and push movements of word cards that were mounted on a moveable stage. Half of the participants were instructed to indicate a positive word meaning with a pull of the stage towards them (approach) and a negative meaning with a push of the stage away from them (avoidance); the other half received the reverse valence-movement assignment. The results showed that participants were faster to pull favorably evaluated words towards them and to push negatively evaluated words away from them than vice versa.

Two different accounts have been proposed to explain this kind of affective-mapping effect with instrumental behaviors: According to the *specific-muscle-activation account*, movement properties of an arm extension (avoidance) are linked with negative stimulus evaluations and motor patterns of an arm flexion (approach) are associated with positive stimulus evaluations, respectively (Cacioppo, Priester, & Berntson, 1993; Centerbar & Clore, 2006; Cretenet & Dru, 2004; Neumann & Strack, 2000). According to the *distance-regulation account*, affective-mapping effects are due to a compatibility relation between evaluative meaning and responses that serve to decrease (approach) or to increase (avoidance) the distance between the person and the evaluated stimulus (Schneirla, 1959; Solarz, 1960). Both accounts rely on a rather exclusive body of evidence that will be separately discussed below.

Affective-Mapping Effects Supporting Specific-Muscle-Activation Accounts

In many studies, the mere assignment of pushing and pulling lever movements to presentations of affective stimuli was sufficient to engender affective-mapping effects: Participants were faster to pull a lever towards them in the presence of a positively valenced stimulus and to push a lever away from them in response to a negatively evaluated stimulus (e.g., Chen & Bargh, 1999; Da Gloria, Pahlavan, Duda, & Bonnet, 1994; Duckworth, Bargh, Garcia, & Chaiken, 2002; Rinck & Becker, 2007). Such findings are typically explained with long-term associations between stimulus evaluations and motor representations that code biceps-flexing and -extending behaviors, assuming a (bidirectional) priming influence of stimulus evaluations on the associated motor representations (Chen & Bargh, 1999; Neumann et al., 2003). Note that valence boosts of lever movements towards and away from the body are not open to an explanation in terms of distance regulation functions because the distance between the person and the evaluated stimuli is not affected by the movement execution.

Additional support for an automatic link between evaluations and arm movements of flexion and extension comes from a study by Rotteveel and Phaf (2004) that required button presses instead of lever movements in evaluative classifications of facial displays expressing joy (positive) and anger (negative). The response buttons were positioned perpendicularly above and below a home button on a vertical stand, and the participants were to push the lower or upper button in response to the emotional valence of the facial expression. The results revealed that participants performed better in classifying angry facial expressions with an arm-extending push of the lower button and happy facial displays with an arm-flexing push of the upper button than in the reverse assignment. This result pattern is difficult to reconcile with a distance-regulation account because (a) the distance between the evaluated stimuli and the physical self was unaffected by the movements, and (b) both positive and negative stimuli demanded a distance decrease between the hands and the response buttons. Just like Chen and Bargh (1999), Rotteveel and Phaf proposed a link between arm flexion and positive valence and arm extension and negative valence as an explanation of their findings.

Affective-Mapping Effects Supporting Distance-Regulation Accounts

A number of studies show that affective congruency effects between evaluated stimuli and distance-regulating motor responses emerge independently of– or even in opposition to–an influence of arm flexion and extension movements. For example, in one study (De Houwer, Crombez, Baeyens, & Hermans, 2001), participants were faster to press a button that moved a virtual manikin towards a positive word than a button that moved the manikin away from the favorably evaluated word; the reverse facilitation was observed for button presses that steered the manikin away from positively and negatively valenced words on the monitor screen. This study shows that the initiation of actions producing distance-regulating effects is sensitive to valence activations even on a highly abstract, symbolic level and that movement attributes of arm flexion and extension are not necessary for compatibility effects between evaluations and (symbolic) approach–withdrawal behavior.

Other studies systematically pitted an influence of distance-regulating functions against an effect of arm flexion and extension. Lavender and Hommel (2007) changed the reference point of lever movements from the physical self to the monitor screen that displayed emotional pictures.[1] Participants were faster to classify positive pictures with arm-extending lever movements towards the screen and negative pictures with arm-flexing lever movements away from the screen than with the reverse valence-response assignments. This result is in line with the outcome of another study (Wentura, Rothermund, & Bak, 2000) that showed faster releases of a (permanently pressed) response button that was affixed below the stimulus presentation screen with an arm-flexing withdrawal response in classifications of (other-relevant) negative stimuli and faster presses of this button with an arm-extending reach movement in reactions to (other-relevant) positive stimuli. In these studies, distance-regulating functions were obviously more effective in coding approach and avoidance than intrinsic properties of arm movements.

The studies described above do not rule out the possibility that distance-regulating functions are just superimposed upon the default value of arm extension and flexion. Available evidence, however, renders such a default implication model rather unlikely (cf. Tamir, Robinson, Clore, Martin, & Whitaker, 2004). First, there is now broad evidence for an evaluative goal-dependency of automatic activations of approach (arm flexion) and avoidance (arm extension) behaviors: Rotteveel and Phaf (2004) as well as Lavender and Hommel (2007) observed reliable effects of affective stimuli on arm-extending and -bending responses only in evaluative classifications but not in gender or spatial orientation judgments of the emotional stimuli.[2] This conditionality of evaluative congruency effects argues against a hard-wired, fixed effect of biceps and triceps activations; instead, the congruency relation between affective stimuli and approach and avoidance behavior is located on a representational level that is sensitive to contextual variables. Second, some experiments failed to observe an influence of arm flexion and extension in reaction times to affective stimuli even within evaluative processing conditions (e.g., Rotteveel & Phaf, 2004, Exp. 3). Markman and Brendl (2005) devised an ingenious experimental setup to disentangle effects of arm flexion and extension from movement effects of distance regulation. Positive and negative words were presented either in front of or behind the name of the participant that was written in the middle of a corridor on a computer screen, and participants were instructed to move the words with a lever press either towards or away from their name, depending on the valence of the word. Participants were consistently faster to move positive words toward their name on the screen than away from their name; the opposite pattern was found for responses to negative words. Importantly, this finding was obtained even if the words were presented in front of the name so that the toward-response required an arm-extending movement whereas the away-response required an arm-bending response. This result pattern not only provides additional evidence for the importance of distance-regulating effects in approach and avoidance behavior but also shows that an influence of arm flexion and extension on movement initiation is virtually absent in these experimental conditions.[3] This and other findings (Lavender & Hommel, 2007; Rotteveel & Phaf, 2004) contradict the notion of a default value of arm-extending and -flexing movements that is superimposed by more effective distance-regulating effects. Instead, it seems that the influence of arm positions is just replaced by a coding in terms of distance-regulations on a representational level.

To summarize, many experimental studies agree on an automatic influence of affective stimuli on the initiation of approach and avoidance behaviors despite very different conceptualizations of approach and avoidance. In our view, it is fascinating that structurally very similar valence modulations of approach and avoidance responses were observed in such diverse behaviors as eye blinking (Lang et al., 1990) and virtual running movements of a manikin on the computer screen (De Houwer et al., 2001). This generality of empirical findings stands in sharp contrast with the specificity of explanatory principles that were proposed to account for a match of certain behavior classes with valences, most notably (a) biological functions (protection, defense, consumption, copulation; e.g., Lang et al., 1990), (b) distance-regulation (distance increase or decrease to the evaluated object; e.g., Solarz, 1960), (c) and specific muscle or motor activations (arm flexion and extension; e.g., Rotteveel & Phaf, 2004). Furthermore, the simultaneous application of two or more of these criteria frequently causes inconsistencies in behavior classifications of approach and avoidance, for example, when defensive reactions involve a distance decrease (e.g., defensive biting, Ulrich & Azrin, 1962), or when flexor activations serve protective purposes (e.g., in the withdrawal reflex, Clarke & Harris, 2004), or increase the distance to the evaluated stimulus (e.g., Wentura et al., 2000). Accordingly, research into valence modulations of motor behavior relies on very different–and sometimes even exclusive–definitions of approach and avoidance behavior that hampers a cross-talk between different research strands in this field.

Evaluative Coding of Approach and Avoidance Reactions

In this article, we want to propose an alternative approach to the definition of approach and avoidance behavior that might integrate most of the empirical findings reviewed above. More precisely, we propose that mental representations of approach and avoidance go along with evaluative codings of these behaviors that could match or mismatch the valence of the psychological situation reacted to. In line with an affective S-R compatibility principle, we then expect faster responses in case of an evaluative S-R match than in case of an evaluative S-R code mismatch (De Houwer, 2003a; Klauer & Musch, 2003).

The evaluative-response-coding view rests on the following assumptions. First, it assumes that evaluative implications of action instructions and action goals assign affective codes to motor responses on a representational level: Representations of behaviors referred to as *approach* should go along with a positive response

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[1] This experimental setup is structurally analogous to moving the hand towards the evaluated stimulus and withdrawing the hand from the evaluated stimulus.

[2] Rotteveel and Phaf (2004) and Lavender and Hommel (2007) pointed out that salient and obtrusive manipulations of the emotional value of stimuli might induce an evaluative processing strategy even without an explicit instruction to do so, explaining purported goal-independent congruency effects in single response tasks (Chen & Bargh, 1999, Exp. 2) and lexical decision tasks (Wentura et al., 2000, Exp. 3).

[3] A test of an interaction between movement direction (push vs. pull) and stimulus valence even revealed the opposite pattern than expected from a default implication account with faster push responses in positive evaluations and faster pull responses in negative evaluations.

coding and representations of behaviors referring to *avoidance* should incorporate a negative response code. These evaluative codings of motor actions are assumed to be sensitive to personal and situational constraints, taking task demands and current goals into account. Second, motor action codings are assumed to be networks of distributed feature codes that specify the action properties on a variety of dimensions including the evaluative one (Hommel, Müsseler, Aschersleben, & Prinz, 2001; Lavender & Hommel, 2007; Rosenbaum, 1980; Schmidt, 1975). The affective value of motor representations might be fixed in a limited set of behavioral reflexes (Bolles, 1970; Lang et al., 1990); but, in the majority of human actions, the affective response code is flexibly set according to current goals and relevant situational constraints. Evaluative response codings tailored to the task at hand can hence explain why physically identical lever movements are performed differently in response to identical affective stimuli. Third, the codes that control instrumental behaviors might be directly determined by the response labels that are used in the task instructions and by relevant semantic action knowledge, as research into cognitive action control suggests (Barsalou, 2002; Glenberg & Kaschak, 2002; Lindemann, Stenneken, van Schie, & Bekkering, 2006; Wenke & Frensch, 2005). In line with this research, the evaluative meaning of response labels used in the action instructions might analogously determine the evaluative action codes controlling motor behavior, provided that these response labels are in the service of the current task goal (Memelink & Hommel, 2005).

In sum, the evaluative-response-coding view agrees with the theoretical notion that an influence of affective stimuli on motor behavior is mediated on the representational level of perception and action (cf. Markman & Brendl, 2005; Neumann et al., 2003); but it deviates from other accounts in the assumption that evaluative codings are not restricted to some particular types of motor behaviors (e.g., reflexes) or to some particular behavioral functions (e.g., distance-regulation). Instead, we propose that valence modulations of motor reactions can basically be observed with all types of behaviors that are associated with evaluative codes, and that an identical motor reaction can be positively coded in one context and negatively coded in another action context.

Overview of Experiments

In the following, we put predictions of an evaluative-response-coding view to an empirical test. Research on response competition mechanisms in sequential affective priming and in (extrinsic) affective Simon-tasks has accrued much evidence that instructing participants to press a positive and a negative button endows this motor response with a respective evaluative meaning whose activation is partially controlled by (irrelevant) affective stimuli (e.g., De Houwer, 2003b; De Houwer et al., 2001; De Houwer, Hermans, Rothermund, & Wentura, 2002; Klauer, Eder, Greenwald, & Abrams, 2007; Klauer, Musch, & Eder, 2005; for overviews see De Houwer, 2003a; Klauer & Musch, 2003; Wentura & Rothermund, 2003). We hypothesize a similar evaluative coding mechanism to be at work in typical experiments investigating approach- and avoidance-related movements. More precisely, we expect the valence of movements towards and away from a reference point to be critically dependent upon the evaluative meaning of the response labels used to steer these behaviors: A movement towards a reference point should be positively coded because the concept *towards* is positively evaluated, and a movement away from a reference should acquire a negative evaluative meaning because of a negative connotation of the concept *away*. An important prediction from this account is that the evaluative meaning of motor responses can be changed just by a change of the semantic labels that are used to describe the movements in the task instructions. For example, labeling the pull of a lever as a downward-movement should load this movement negatively because of the negative connotation of the concept *downwards*, whereas the same movement would acquire a positive mental representation if it were instructed as pulling the lever *towards* oneself. Conversely, an instruction to execute an upward movement should impose a positive meaning on this movement in line with a positive evaluation of the concept *upwards*. Accordingly, action instructions are hypothesized to set the evaluative attributes of motor movements, and the evaluative coding of identical motor movements should vary with changes of the evaluative action frame.

The experiments described below tested this hypothesis of an instruction-dependent valence coding of approach and avoidance movements. First, we describe results of a rating study that show that the (action) concepts *towards*, *away*, *upwards,* and *downwards* do indeed vary systematically in their evaluative connotation. We then report four experiments that applied these response labels to identical lever movements in instructing them either as movements *towards* and *away* or as *downward* and *upward* movements. Experiments 1 and 2 applied these response instructions to arm-bending pull and arm-extending push movements of a lever that were used as a standard operationalization of approach and avoidance behavior (e.g., Chen & Bargh, 1999). Experiment 3 framed lever movements to the right and left in *towards–away* and *upwards–downwards* instructions. Experiment 4 replicated the setup of Experiment 1 with random presentations of the mapping rules within a block of trials, granting short and long implementation times of the mapping rules. Figure 1 gives an overview of the response-label–movement assignments in all four experiments. We predicted for all four experiments that labeling lever movements *downwards* and *upwards* will reverse the standard affective-mapping effect obtained with *towards* and *away* lever instructions despite the execution of identical motor movements and despite the irrelevance of upwards and downwards codings for distance-regulation. In Experiment 5, the words *towards* and *away* were presented as go signals to test whether a mere symbolic congruency relation between affective stimuli and these written go signals is sufficient to engender affective congruency effects. In line with

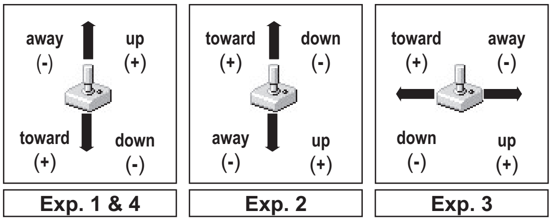

Figure 1. Overview of lever-movement–response–label assignments in Experiments 1–4. Assumed movement valence is indicated with a plus or minus sign. In Experiment 3, the response-label assignment to the left and right joystick movements was counterbalanced across participants.

a response-selection account of affective-mapping effects, we hypothesized an influence of an evaluative match between the go signals and the target stimuli only if the to-be-executed responses were evaluatively coded but not with neutrally framed left and right lever movements.

Response-Label–Rating Study

Method

Participants

Forty-two students (34 women) were asked to rate several words at the end of an unrelated experiment. The participants were between 18 and 27 years of age ($M = 20.9$ years), and all of them were native speakers of German.

Procedure

Participants were asked to rate the German words *hin* (*towards*), *weg* (*away*), *oben* (*up*), *unten* (*down*), *links* (*left*), *rechts* (*right*), and *Mitte* (*middle*) in random order on a scale ranging from −4 (very negative) to +4 (very positive). Each word was shown at the center of the computer screen with a 9-point scale displayed below, and the evaluative rating was entered with a mouse button press on the respective scale value box without time pressure.

Results and Discussion

Figure 2 shows the mean evaluative rating of each response-label word. Pairwise comparisons of the mean evaluative ratings in *t* tests for dependent samples confirmed the expected differences in evaluative connotations: The word *towards* (*hin*; $M = 1.21$, $SD = 1.37$) was rated more positively than *away* (*weg*; $M = -0.74$, $SD = 1.85$), $t(41) = 5.21$, $p < .001$, and *up* (*oben*; $M = 1.52$, $SD = 1.47$) was judged more positively in meaning than *down* (*unten*; $M = -0.95$, $SD = 1.67$), $t(41) = 6.20$, $p < .001$. The evaluative meanings of *right* (*rechts*; $M = -0.26$, $SD = 1.7$) and *left* (*links*; $M = -0.12$, $SD = 1.31$) were not judged differently, $t < 1$, and the word *middle* (*Mitte*) was positively evaluated ($M = 1.74$, $SD = 1.4$). The explicit ratings of the German equivalents of *up* and *down* thus converge with experimental research that revealed associations between vertical positions and positive and negative evaluations (e.g., Crawford, Margolies, Drake, & Murphy, 2006; Meier & Robinson, 2004; but see also Hampe, 2004).

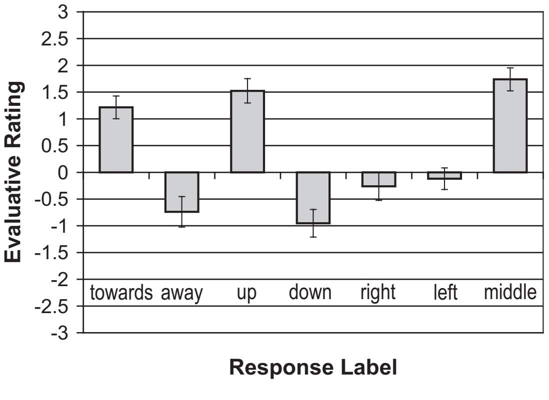

Figure 2. Mean evaluative rating of response labels on a scale of −4 to +4 (with standard error bars).

Experiment 1

In Experiment 1, we applied the response labels *towards–away* and *up–down* to push and pull movements of a joystick lever. One group of participants was instructed to pull the joystick lever *towards* them and to push the lever *away* from them in evaluative classifications; another participant group was instructed to move the lever *downwards* (pull-movement) and *upwards* (push-movement) in word evaluations. Accordingly, response labels of opposite evaluative meaning were assigned to identical push and pull movements of a joystick lever in evaluative word decisions (see Figure 1). We expected faster reactions to affective stimuli with responses whose label connotation matched the evaluative word meaning regardless of the requirement of a push or pull movement.

Method

Participants

Twenty-eight students (25 women, 3 men) with normal or corrected-to-normal visual acuity volunteered for the experiment. Two participants were left handed. The participants were between 19 and 23 years of age ($M = 20.9$ years), and all of them were fluent in German. None had participated in the rating study.

Apparatus and Stimuli

Participants were seated at a distance of 50 cm from a 17-in. VGA color monitor with 70 Hz refresh rate. An IBM compatible analogue joystick was connected to the game port of the computer and placed between the monitor and the participant. The participant was asked to grip the lever of the joystick with the dominant hand and to perform the lever movements as fast as possible until the dead stop is reached. Stimulus presentation and measurement of response latencies were controlled by a software timer with video synchronization (Haussmann, 1992).

The response-specifying stimuli were 24 clearly positive ($M = 2.0$, $SD = 0.36$) and 24 clearly negative adjectives ($M = -1.75$, $SD = 0.53$) selected from a standardized word pool on the basis of their evaluative norms (Schwibbe, Röder, Schwibbe, Borchardt, & Geiken-Pophanken, 1981; see Appendix). The subsets of positive and negative adjectives did not differ in frequency of usage and number of letters (range: 4–9), both $Fs < 1$. An additional six positive and six negative adjectives were selected for practice trials. All adjectives were presented in lower case letters in white-on-black at the center of the computer screen.

Procedure

Participants were instructed to classify the valence of positive and negative words as fast as possible with push and pull movements of the joystick lever. The lever reactions were introduced to one-half of the participants as movements "towards and away from themselves" and to the other half as "downwards and upwards" movements. The wording of the task instruction text was in all other respects identical, and participants were randomly assigned to the two instruction groups.

The response assignment to the valence was varied within subjects in the first and second half of the experiment. In one-half of the experimental session, participants were instructed to push the lever *away* from them or *upwards* to indicate a positive word meaning and to pull the lever *towards* them or *downwards* to signal a negative word meaning. This positive–pull and negative–push assignment constituted a congruent mapping according to standard-muscle-activation accounts of approach- and avoidance-related lever movements. In the other half of the trials, the valence-movement mapping was reversed, resulting in an incongruent mapping according to an arm-flexion-and-extension account. The order of congruent and incongruent mapping rules was balanced across participants.

To prevent internal recodings of the lever movements within the experimental session, we randomly interspersed experimental trials that required a reaction to a written response label instead of a word evaluation. The response labels were written in white upper case letters at the center of the screen, and the participants were to respond to these response labels as quickly as possible with a respective lever movement.

An experimental trial started with a brief presentation (200 ms) of a fixation sign (an asterisk) in the middle of the screen. Following an additional interval of 100 ms, the word was presented until response registration. Participants were urged to hold the joystick in the middle position at the time of the stimulus presentation and to react to the word as quickly as possible. Response registration took place when the joystick was moved in any direction to a considerable degree. At the end of a trial, feedback was given on an incorrect lever position at the time of the word presentation, a movement in a wrong direction, and/or when a reaction time exceeded 1 s. The next trial started after 1,700 ms.

The experiment consisted of 240 experimental trials, divided into eight blocks of 30 trials. Each block comprised presentations of 12 positive and 12 negative adjectives, and the remaining 6 trials involved three presentations of each response-label word of the respective instruction group. In two experimental blocks, all adjectives were presented in a randomized order. The valence-response assignment was changed after the first four blocks, and each participant worked through 18 practice trials (12 valence and 6 label classifications) before the start of the first and fifth experimental block to get familiar with the task procedure and the (new) mapping rules.

Results

Congruency of the valence-movement mapping was defined according to the movement components of arm flexion and arm extension in pulling and pushing lever reactions (i.e., pull = approach, push = avoidance). Evaluation trials with lever movements in the wrong direction (8.5%% of all trials) and latencies below 100 ms or above 1,200 ms (1.5%% of all trials) were discarded from reaction time analysis.

Evaluation latencies were analyzed by means of a mixed 2 × 2 × 2 analysis of variance (ANOVA) with instruction group (towards–away vs. up–down) as a between-subjects factor and affective mapping (congruent: positive–pull, negative–push vs. incongruent: positive–push, negative–pull) and stimulus valence (positive vs. negative) as within-subjects factors. As expected, the ANOVA revealed an interaction between affective mapping and instruction group, $F(1, 26) = 17.7$, $p < .001$ (see Figure 3): Instructing participants that pull and push responses were movements *towards* and *away* from them led to faster evaluations with a positive–pull/negative–push mapping ($M = 697$ ms, $SE = 14.8$) than with a positive–push/negative–pull assignment ($M = 736$ ms, $SE = 13.1$), $t(13) = -3.0$, $p < .01$, thus replicating the standard mapping effect reported by Chen and Bargh (1999) and others. This response facilitation pattern was completely reversed with designations of a lever pull and push as *downward* and *upward* movements: With these instructions, the (purportedly compatible) positive–pull/negative–push mapping ($M = 705$ ms, $SE = 14.8$) yielded longer reaction times than the (purportedly incompatible) positive–push/negative–pull mapping ($M = 673$ ms, $SE = 13.1$), $t(13) = 2.86$, $p < .05$. The main effects and the interactions with stimulus valence were not significant (all ps $> .13$).

An analysis of the average error rates (in percentage) in an analogous mixed ANOVA revealed a similar interaction between affective mapping and instruction group, $F(1, 26) = 11.9$, $p < .01$. Participants made fewer errors in pushing the lever *away* and pulling the joystick *towards* them when the valence mapping was congruent ($M = 6.2\%\%$, $SE = 1.3$) than when it was incongruent ($M = 10.3\%\%$, $SE = 1.4$), $t(13) = -2.78$, $p < .05$. This pattern was reversed to an advantage of the incongruent mapping ($M = 7.3\%\%$, $SE = 1.4$) over the congruent valence–movement assignment ($M = 10.0\%\%$, $SE = 1.3$) when the participants pushed a joystick *upwards* and pulled a joystick *downwards*, $t(13) = 2.05$, $p < .05$ (one-tailed). The main effects and the interactions with stimulus valence were not significant (all ps $> .26$).

Discussion

The results are clear-cut. With stimuli and response movements kept equal, just exchanging the instruction words *towards* and *away* with *downwards* and *upwards* completely reversed the result

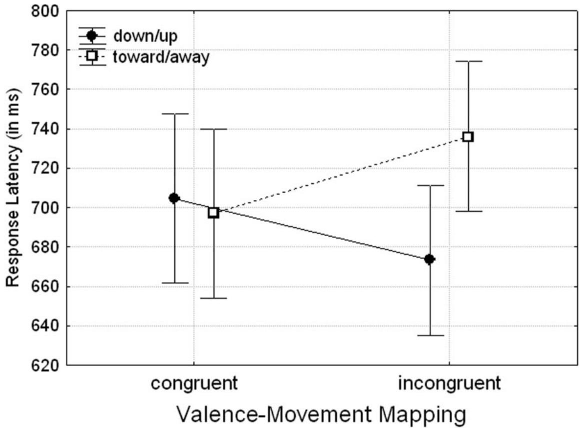

Figure 3. Mean reaction times to positive and negative words with joystick movements labeled as *towards–away* or *upward–downward* in Experiment 1. Congruency of the valence-movement mapping is defined along a correspondence between stimulus valence and arm movement (congruent: positive–pull/negative–push; incongruent: positive–push/negative–pull). Error bars display the 0.95 confidence interval.

pattern: Whereas the towards–up instruction group replicated the standard affective-mapping effect, the down–up instruction group was markedly slower to pull a joystick *downwards* in evaluations of positive stimuli and to push a lever *upwards* in reactions to a negative stimuli, even though previous studies have claimed a facilitatory link between positive evaluations and arm-bending (pull) movements and between negative evaluations and arm-extending (push) motor patterns (e.g., Cacioppo et al., 1993; Chen & Bargh, 1999; Rotteveel & Phaf, 2004). Accordingly, our data support the conclusion drawn in other studies that arm flexion and extension are not suited to explain valence modulations of lever movements (e.g., Lavender & Hommel, 2007; Markman & Brendl, 2005). The observation of a reversed affective-mapping effect in the downward–upward instruction group can also hardly be reconciled with a distance-control account, because (a) the same physical movements were used in both conditions and (b) the new response labels were unrelated to distance regulation. In a second experiment, we attempted to test predictions of a distance-regulation account more directly against our evaluative coding explanation.

Experiment 2

Distance-regulation accounts define approach and avoidance actions as motor patterns that serve to decrease (approach) or increase (avoidance) the distance between the agent (or self) and the evaluated object. This distance-regulating definition can be applied to a lever task configuration that instructs physical lever reactions towards and away from the evaluated stimulus. Using such an experimental setup, Lavender and Hommel (2007) showed that participants were faster to move their hand with the lever towards the screen when the monitor showed a positively evaluated picture rather than a negatively valenced picture; conversely, the lever was pulled back more rapidly from the monitor when it showed a negative picture rather than a positive picture (see Wentura et al., 2000, for an identical finding in a structurally similar setup). In Experiment 2, we adopted this experimental setup with an additional variation of the response-label instructions (see Figure 1): One-half of the participants were instructed to move the lever *towards* (push) and *away* (pull) from the monitor screen, and the other half were to move the lever *downwards* (push) and *upwards* (pull). If the distance-regulation account is correct, moving the hand and the lever towards positively evaluated stimuli and pulling the lever back from unfavorably evaluated words (congruent mapping) should be invariantly faster than pulling the lever back from positive stimuli and pushing it towards negative stimuli (incongruent mapping). The evaluative coding view alternatively predicts a reversed affective-mapping effect with down–up instructions.

Method

Participants

Thirty-two students (24 women, 8 men) with normal or corrected-to-normal visual acuity volunteered for the experiment, 16 in each instruction group. All but 2 participants were right-handed. The participants were between 19 and 24 years of age (M = 20.8 years) and all of them were fluent in German. None participated in the rating study.

Apparatus, Stimuli, and Procedure

Apparatus, stimuli, and procedure were identical to Experiment 1 except for the following changes: The assignments of the response labels *towards–away* and *up–down* to the joystick movements were now reversed to those in Experiment 1. As Figure 1 illustrates, a push response was instructed either as a movement *towards* the screen or as a *downwards* movement; a pull response was introduced either as a movement *away* from the screen or as an *upward* movement depending on the instruction group. For additional practice of the label-movement assignments, the experiment proper started with a practice block with six reaction trials to each of the two response labels of the respective instruction group in randomized order.

Results

Congruency of the valence-movement mapping was defined according to a distance increase or decrease of the lever-moving hand to the evaluated stimulus (i.e., push equaling approach, pull equaling avoidance). Evaluation trials with lever movements in the wrong direction (8.6%% of all trials) and latencies below 100 ms or above 1,200 ms (1.5%% of all trials) were discarded from reaction time analysis.

A mixed 2 × 2 × 2 ANOVA of the evaluation latencies with instruction group (towards–away vs. up–down) as a between-subjects factor and affective mapping (congruent: positive–push, negative–pull vs. incongruent: positive–pull, negative–push) and stimulus valence (positive vs. negative) as within-subjects factors did not reveal a significant main effect of affective mapping, $F(1, 30) = 3.05$, $p = .09$, but it did reveal a significant interaction between affective mapping and instruction group, $F(1, 30) = 22.1$, $p < .001$. As shown in Figure 4, with movement instructions

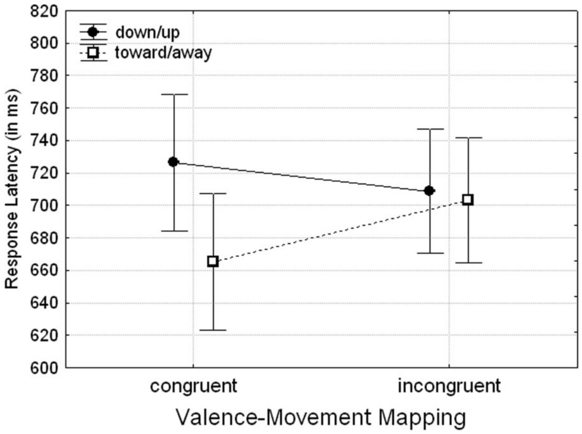

Figure 4. Mean reaction times to positive and negative words with joystick movements labeled as *towards–away* or *upward–downward* in Experiment 2. Congruency of the valence-movement mapping is defined along a correspondence between stimulus valence and distance change (congruent: positive–push/negative–pull; incongruent: positive–pull/negative–push). Error bars display the 0.95 confidence interval.

toward and *away* from the screen, participants evaluated positive and negative words faster with a positive–push/negative–pull mapping ($M = 665$ ms, $SE = 15.5$) than with a positive–pull/negative–push assignment ($M = 703$ ms, $SE = 15.3$), $t(15) = -4.98$, $p < .001$. This response facilitation pattern was reversed with designations of the same lever reactions as *downward* and *upward* movements: In this instruction group, the (purportedly compatible) positive–push/negative–pull mapping ($M = 726$ ms, $SE = 13.6$) yielded longer reaction times than the (purportedly incompatible) positive–pull/negative–push mapping ($M = 709$ ms, $SE = 10.9$), $t(15) = 1.91$, $p < .05$ (one-tailed). The main effect of instruction group, $F(1, 30) = 22.1$, $p = .09$, and the interaction between instruction group and word valence approached significance, $F(1, 30) = 22.1$, $p = .07$. The main effect of stimulus valence and all other interactions were not significant (all ps $> .24$).

In an analogous mixed ANOVA of the mean error percent rates, the interaction between affective mapping and instruction group was not significant, $F(1, 30) = 1.17$, $p = .29$. In both instruction groups, slightly fewer movement errors were made when the valence-mapping was congruent (towards–away: $M = 6.9\%\%$, $SE = 1.1$; down–up: $M = 6.6\%\%$, $SE = 1.1$) than when it was incongruent (towards–away: $M = 9.2\%\%$, $SE = 1.3$; down–up: $M = 7.2\%\%$, $SE = 1.3$). The main effect of affective mapping, however, did not reach significance, $F(1, 30) = 3.36$, $p = .08$. All other main effects and interactions were not significant (with all ps $> .15$).

Discussion

Using a distance control definition of approach and avoidance movements, the results of Experiment 2 again show a reversed affective-mapping effect with up–down instructions of lever movements. With these instructions, participants were faster to push the joystick *downwards* in negative evaluations and to pull the lever *upwards* in positive evaluations, even though a movement-based distance-regulation account would predict faster lever pushes towards positively evaluated stimuli and faster joystick pulls away from negatively evaluated stimuli irrespective of the movement label. Accordingly, neither specific-muscle-activation patterns nor distance-regulation codings can account for reversed affective-mapping effects with *downwards*- and *upwards*-instructed lever reactions; instead, it seems that the initiation of *upwards* and *towards* movements and the selection of *downwards* and *away* movements are similarly affected by the positive and negative evaluative connotations of the response labels.

Experiment 3

The evaluative-coding view expects faster movement initiations in the case of an evaluative S-R match than in the case of an evaluative S-R mismatch irrespective of the physical movements that are actually performed. Accordingly, a valence boost of lever movements should not be restricted to lever reactions in the sagittal direction involving specific muscle activations of flexion and extension or distance regulations; instead, affective-mapping effects are also predicted for movements that are by themselves unrelated to approach–avoidance or distance regulation when participants are enforced by task goals and task procedures to evaluatively code these movements.

In Experiment 3, we tested this prediction with assignments of towards–away and up–down instructions to left and right joystick movements (see Figure 1): One-half of the participants were instructed to perform left and right lever movements as *towards* and *away* reactions; the other half were instructed to execute these movements as *downwards* and *upwards* reactions. In line with the evaluative coding view, we expected faster selections of *upwards*- and *towards*-labeled lever movements in positive evaluations and an analogous facilitation of *downwards*- and *away*-labeled lever movements in negative stimulus evaluations.

Method

Participants

Thirty-four students with normal or corrected-to-normal visual acuity volunteered for the experiment. None participated in the rating study. The data sets of two participants were dropped from data analyses because they produced errors in more than one-third of the reactions to the response labels. All but two of the remaining participants (7 men, 25 women) were right-handed. They were between 18 and 31 years of age ($M = 21.3$ years), and all of them were fluent in German.

Apparatus, Stimuli, and Procedure

Evaluative classifications and label classifications were now performed with left and right lever movements that were introduced to one-half of the participants as movements *towards* and *away* (without naming a reference point) and to the other half as *downwards* and *upwards* movements (see Figure 1). Within each instruction group, the assignment of the respective response labels to the left and right movement was counterbalanced across participants so that each response label was equally often applied to left and right movements in the respective instruction group. All other conditions were identical with Experiment 2.

Results

Congruency of the valence-movement mapping was defined according to a valence match between stimulus evaluations and evaluative response (label) meaning (i.e., positive equaling up–toward, negative equaling down–away). Evaluation trials with lever movements in the wrong direction (8.3%% of all trials) and latencies below 100 ms or above 1,200 ms (2.2%% of all trials) were discarded from reaction time analysis.

Evaluation latencies were analyzed by means of a mixed 2 × 2 × 2 × 2 ANOVA with instruction group (towards–away vs. up–down) and label mapping (left: toward/down, right: away/up vs. left: away/up, right: toward/down) as between-subjects factors and affective mapping (congruent: positive–up/toward, negative–down/away vs. incongruent: positive–down/away, negative–up/toward) and stimulus valence (positive vs. negative) as within-subjects factors. As expected, the ANOVA revealed a significant main effect of affective mapping, $F(1, 28) = 13.71$, $p < .001$, that was not qualified by the instruction group, $F < 1$. As shown in Figure 5, members of the toward–away group classified positive and negative words faster with *towards*- and *away*-instructed lever movements whose response-label connotation matched ($M = 708$ ms, $SE = 12.0$) rather than mismatched the evaluative word

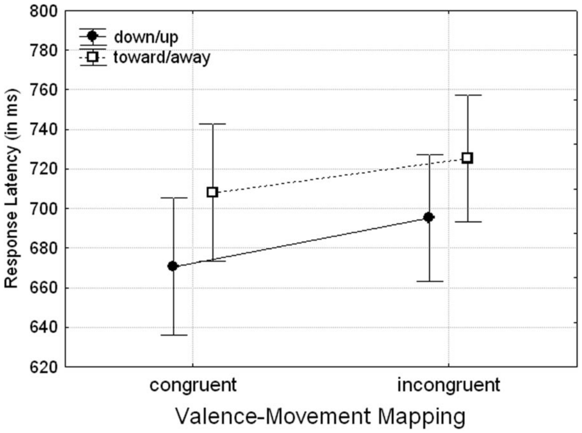

Figure 5. Mean reaction times to positive and negative words with left and right joystick movements labeled *towards–away* or *upward–downward* in Experiment 3. Congruency of the valence-movement mapping is defined along an evaluative stimulus-response label match (congruent: positive–toward/negative–away, positive–upward/negative–downward; incongruent: positive–away/negative–toward, positive–downward/negative–upward). Error bars display the 0.95 confidence interval.

meaning (M = 725 ms, SE = 11.0), $t(15) = -2.09$, $p = .054$. The up–down-instructed participant group produced an analogous facilitation pattern with faster reactions to positive and negative words with *upwards* and *downwards*-labeled lever movements whose connotation matched (M = 671 ms, SE = 12.0) rather than mismatched the evaluative word meaning (M = 695 ms, SE = 11.0), $t(15) = -3.47$, $p < .01$. The main effect of instruction group was significant, $F(1, 28) = 4.89$, $p < .05$, indicating faster reactions with down–up instructions than with toward–away instructions. The main effect of label assignment also reached significance, $F(1, 28) = 8.47$, $p < .01$, with faster reactions when the labels *toward*s and *down* were applied to a left rather than to a right lever movement. The fourth-order interaction approached significance, $F(1, 28) = 4.08$, $p = .053$, without any meaningful modification of the affective-mapping effect. The main effect of stimulus valence and all other interactions were not significant (all ps > .23).

In an analogous mixed ANOVA of the mean error percent rates, the main effect of affective mapping ($M_{congruent}$ = 6.5%%, SE = 1.0; $M_{incongruent}$ = 7.9%%, SE = 1.0), $F(1, 28) = 1.43$, $p = .24$, and its interaction with instruction group, $F(1, 28) = 2.52$, $p = .12$, were not significant. The three-way interaction between instruction group, affective mapping, and stimulus valence, $F(1, 28) = 4.22$, $p < .05$, and the three-way interaction between instruction group, label mapping, and affective mapping, however, reached significance, $F(1, 28) = 4.35$, $p < .05$. Latter interaction revealed a congruency advantage in the toward–away group and a congruency disadvantage in the up–down instruction group when toward–down was mapped onto the left and away–up onto the right movement; however, both instruction groups produced a congruency advantage with the other response-label assignment. The interaction between stimulus valence and label mapping approached significance, $F(1, 28) = 3.79$, $p = .06$, revealing more error-prone classifications of positive stimuli when toward–down was mapped onto the right and away–up onto the left lever movement than with the reversed response-label assignment. All other effects and interactions were not significant (with all ps > .11).

Discussion

Creating a reaction task in which valenced response labels were arbitrarily assigned to left and right joystick movements yielded affective-mapping effects that are similar to those observed in standard lever-movement tasks in the sagittal direction. Responses labeled *towards* or *upwards* were invariably speeded in positive word evaluations, regardless of whether these concepts were applied to physical movements to the left or to the right. The labeling of left and right movements with *downwards* and *away* analogously facilitated the initiation of these movements in negative evaluations. Accordingly, an evaluative match between stimulus valence and response-label connotation seems to be a sufficient condition to produce affective-mapping effects, and there was no difference between valence boosts of responses coded in *toward* and *away* and in *downward* and *upward*.

Experiments 1 to 3 provide clear evidence that the speed of lever movements is influenced by an evaluative match between the response labels used to steer these behaviors and the valence of the stimuli reacted to. In the following experiments, we sought to further generalize this finding over procedural variations that might be telling about the processes underlying affective-mapping effects in these tasks.

In accordance with response-selection accounts of S-R compatibility effects (Eimer, Hommel, & Prinz, 1995; Kornblum, Hasbroucq, & Osman, 1990), we assume that positive and negative stimuli directly trigger corresponding affective responses that are specified by the task requirements. For instance, a positive stimulus automatically activates the positively valent response code *up* if the lever movements were labeled as *up* versus *down* in the task instructions, but it activates the response code *towards* if the movements were labeled as *towards* versus *away*. According to this model, affective-mapping effects are located at a central response selection stage where affective stimuli increase the activation level of congruent response codes that facilitates or interferes with the specification of the required lever movement.

Experiment 4

Experiment 4 tested the response-activation account against an alternative explanation of affective-mapping effects that attributes the effect to an intentional processing route involving memory retrieval (e.g., Costa, Horwitz, & Vaughan, 1966; Fitts & Deininger, 1954; Guiard, Hasbroucq, & Possamai, 1994; Hasbroucq & Guiard, 1991). The memory-retrieval hypothesis assumes that congruent mapping rules (e.g., positive and *up*) are more easily retrieved from memory than incongruent mapping rules (e.g., positive and *down*) because stimulus valence serves as a prime that facilitates retrieval of same-valenced response labels and impedes the retrieval of response labels of the opposite valence (Bower, 1991; Fazio, 2001; Isen, 1984). According to this account, affective congruency effects originate from priming effects that modulate an intentional translation of stimulus valences into responses according to prespecified S-R rules. The effect is located in memory processes and does not involve a direct activation of responses via affective response codes.

An implication of the memory-retrieval account is that the strength of affective congruency effects should be directly proportional to the involvement of memory retrieval processes in the task. Retrieval-based affective congruency effects should have a marked influence on response latencies in a situation that places strong demands on memory and should become smaller in a situation that involves memory processes to a lesser degree.

The response-activation account, on the other hand, assumes that affective-mapping effects are mediated by a direct activation of emotional response codes that bypasses processes of an intentional rule specification involving memory-retrieval. Therefore, affective congruency effects of equal strength are predicted for tasks involving high and low amounts of memory retrieval processes.

The different predictions of the two accounts regarding the modulating role of memory demands on affective congruency effects were tested in an experiment that randomly intermixed trials with congruent and incongruent valence-response mappings within blocks of trials and that varied the amount of advance knowledge regarding the mapping rules. In each trial, a separate mapping signal was presented that indicated whether the congruent or incongruent mapping rules should be applied to the stimulus classification. To vary the involvement of memory retrieval processes during a trial, the mapping signal was presented either a long time interval before (long preparation) or simultaneously with the presentation of the affective stimulus (no advance preparation). Presenting the mapping signal before the arrival of the affective stimulus allowed for an advance reduction of the number of applicable S-R rules from four to two (a specific rule had to be selected from either the compatible or the incompatible subset of rules). Such an advance preparation was not possible in the no-preparation condition, which required responding to the affective stimulus without advance knowledge of which subset of the mapping rules had to be applied.

The memory-retrieval account predicts larger affective congruency effects in the no-preparation condition than in the advance preparation condition. Affective priming effects can influence the whole memory process of retrieving the correct rule from a total of four possible S-R assignments in the former case. In the long-preparation condition, affective priming should have only a restricted influence because part of the rule-specification process is already completed before the stimulus is shown and should thus be immune against influences of stimulus valence. According to the response-activation account, however, the strength of affective-mapping effects should not differ between the preparation and no-preparation conditions because direct response code activations should interact with the outcome and not with the process of response specification.

As in Experiment 1, congruency of the valence-movement mapping was defined according to the movement components of arm flexion and arm extension in pulling and pushing lever reactions (i.e., congruent: positive–pull, negative–push; incongruent: positive–push, negative–pull). One-half of the participants were instructed to pull the joystick lever *towards* them and to push the lever *away* from them; the remaining ones were instructed to pull the lever *downwards* and to push the lever *upwards* in word evaluations (see Figure 1).

In this experiment, we abstained from an interspersion of response-label trials in the evaluative word-classification trials–participants never reacted to the written response labels with a respective lever movement throughout the entire experiment. With an instruction-only manipulation of the response labels, we intended to strengthen our claim that the mental coding of the lever movements mediates the influence of the response labels on affective congruency effects.

Method

Participants

One-hundred-and-twenty-eight students (84 women, 44 men) with normal or corrected-to-normal visual acuity volunteered for the experiment, 64 in each instruction group. Fifteen participants were left-handed. The participants were between 18 and 43 years of age ($M = 22.1$ years) and all of them were fluent in German. None participated in the rating study.

Apparatus and Stimuli

Apparatus and stimuli were identical to those of Experiment 1. The number of the adjectives for the practice trials was increased to 24 (12 positive, 12 negative). A blue (red-green-blue values: 0, 25, 255) and an orange (red-green-blue values: 225, 25, 0) background color of the monitor screen served as mapping signals.

Design and Procedure

Participants were randomly assigned to each instruction group (toward–away vs. downwards–upwards) and informed that they had to classify the valence of positive and negative words as fast as possible with push and pull movements of the lever according to the color of the background screen (orange vs. blue). Assignment of colors to congruent (positive–pull, negative–push) and incongruent (positive–push, negative–pull) mapping rules was counterbalanced across participants. In addition, the time interval between the mapping signal and the response-imperative adjective was varied between participants, with a switch to a colored background either 1,300 ms before (long preparation) or simultaneously with the adjective presentation (short preparation). This setup resulted in a fully crossed 2 (word valence: positive vs. negative) × 2 (lever movement: push vs. pull) × 2 (instruction group: toward–away vs. up–down) × 2 (preparation interval: short vs. long) factorial design, with word valence and lever movement within-varied and the remaining factors between-varied.

For practice of the color-mapping assignment, participants worked through two practice blocks with 24 trials each that included only trials with a single mapping signal (orange vs. blue). The order of the pure-blocks with congruent and incongruent mapping signals was counterbalanced across participants. These blocks were followed by a third practice block with 24 trials that randomly mixed trials with a congruent and incongruent mapping signals with equal probability. The experimental phase consisted of 192 trials, divided into two blocks of 96 trials. Each block comprised presentations of the congruent and incongruent mapping signals with equal probability, and all 48 adjectives were presented twice in each block in randomized order. The following trial restrictions were imposed upon the list construction of each experimental block: (a) There were no more than 3 trials with an identical mapping signal (orange vs. blue) in a row, (b) repetition trials with consecutive presentations of the same mapping signal comprised more than 43%% and fewer than 54%% of the block trials, and (c) in about half of the repetition and alternation trials a negative adjective was presented. With these trial restrictions, we sought to counteract strategic responding induced by an imbalance of mapping signal alternations and repetitions.

Several measures were taken to ensure a movement coding that complies with the response-label instructions. First, participants were repeatedly asked to complete the mapping rule of the respective mapping signal by typing the corresponding response-label word in the keyboard with only the valence given (e.g., positive required typing *up*, negative required typing *down*). This was done at the start of each block and after each movement error in the practice trials (but not in the experimental blocks). Second, participants were (erroneously) warned that in some trials a written response label would appear instead of an adjective that required a speeded execution of the respective lever movement. These response-label trials were however never presented throughout the experiment.[4]

An experimental trial started with a switch of the black background into a colored background in the long-preparation condition or with a blank black screen in the short-preparation condition. After 1,000 ms, a white fixation sign appeared in the middle of the screen for 200 ms, followed by a blank screen for 100 ms. Then the imperative adjective was presented in white color, accompanied by a color switch of the background in the short-preparation condition. The mapping signal and the adjective remained on the screen until response registration. The time limit for a feedback of too-slow reactions was increased to 2,000 ms. The next trial started after 1 s. All other conditions of the task procedure were identical with Experiment 1.

Results

A congruency factor was defined with positive–pull and negative–push as congruent valence-movement combinations and with positive–push and negative–pull as incongruent combinations. Trials with lever movements in the wrong direction (8.5%% of all trials), with no middle position at the time of the adjective presentation (0.04%% of all trials), and with latencies below 200 ms or above 2,000 ms (2.5%% of all trials) were discarded from reaction time analysis.

A mixed 2 × 2 × 2 ANOVA of the mean response latencies with affective mapping (congruent: positive–pull, negative–push vs. incongruent: positive–push, negative–pull) as within-subjects factor and instruction group (towards–away vs. up–down) and preparation interval (short vs. long) as between-subjects factors yielded a main effect of the preparation interval, $F(1, 124) = 60.5$, $p < .001$. Participants responded in the short-preparation condition ($M = 1{,}086$ ms, $SE = 15.2$) about 167 ms slower than in the long-preparation condition ($M = 919$ ms, $SE = 15.2$). This proves that the participants utilized the long time interval between the mapping signal and the imperative word presentation to implement the correct mapping rule. The main effect of affective mapping missed significance with an overall congruency disadvantage, $F(1, 124) = 3.64$, $p = .059$, that was qualified by the crucial interaction with the instruction group, $F(1, 124) = 49.3$, $p < .001$. Planned comparisons of the means showed that participants instructed to move the lever *towards* and *away* from the body responded faster in trials with a congruent mapping signal ($M = 989$ ms, $SE = 16.4$) than with an incongruent mapping signal ($M = 1{,}030$ ms, $SE = 15.9$), $t(63) = -3.62$, $p < .001$; however, when the same lever movements were labeled *downwards* and *upwards*, this pattern was reversed with faster reactions in trials with an incongruent mapping signal ($M = 960$ ms, $SE = 15.9$) than with a congruent mapping signal ($M = 1{,}031$ ms, $SE = 16.4$), $t(63) = 6.31$, $p < .001$. Importantly, the three-way interaction between affective mapping, instruction group, and preparation interval was far from significance, $F(1, 124) = 0.51$, $p = .82$, revealing affective-mapping effects of similar size in both preparation conditions (see Figure 6).

In an analogous mixed ANOVA of the mean error percent rates (with a neutral lever position at the time of the stimulus presentation), the crucial interaction between affective mapping and instruction group reached significance, $F(1, 124) = 19.3$, $p < .001$. As expected, participants made fewer errors in pushing the lever *away* and pulling the joystick *towards* them when the mapping signal was congruent ($M = 6.9\%\%$, $SE = 0.9$) than when it was incongruent ($M = 9.1\%\%$, $SE = 0.8$), $t(63) = -2.9$, $p < .01$. This pattern was reversed to an advantage of the incongruent mapping ($M = 7.2\%\%$, $SE = 0.8$) over the congruent valence-movement assignment ($M = 10.5\%\%$, $SE = 0.9$) when the participants pushed the lever *upwards* and pulled the joystick *downwards*, $t(63) = 3.24$, $p < .01$. The three-way interaction between affective mapping, instruction group, and preparation interval was not significant, $F(1, 124) = 1.69$, $p = .20$. The interaction between affective mapping and preparation interval missed significance, $F(1, 124) = 3.79$, $p = .054$, with a congruency benefit in the short-preparation condition and a congruency disadvantage in the long-preparation condition. The main effects and all other interactions were not significant (with all ps $> .23$).

Discussion

The results of Experiment 4 replicate the findings of the first experiment. Lever movements were invariably faster with evaluatively congruent mappings of response labels to stimulus valence (positive mapped to toward or up, negative mapped to away or down) than with incongruent mappings (positive mapped to away or down, negative mapped to toward or up), regardless of whether the movement involved an arm-bending pull or an arm-flexing pull. Note that this affective-mapping effect emerged with verbal instructions of the response labels only and that the response labels were never presented as imperative stimuli in the experiment.

Importantly, advance knowledge of the mapping rules did not have an influence on the strength of the affective-mapping effect. Affective congruency effects of equal strength emerged in the long-preparation and no-preparation conditions, indicating that affective-mapping effects are not mediated by an affective priming

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[4] This manipulation was inspired by a study of De Houwer, Beckers, Vandorpe, and Custers (2005, Exp. 2) that showed that the mere announcement of spatial classifications with meaningless pronunciations (e.g., “bee” and “boo”) is sufficient for task-irrelevant stimulus positions to exert a biasing influence upon the selection between these pronunciations (the so-called extrinsic Simon-effect).

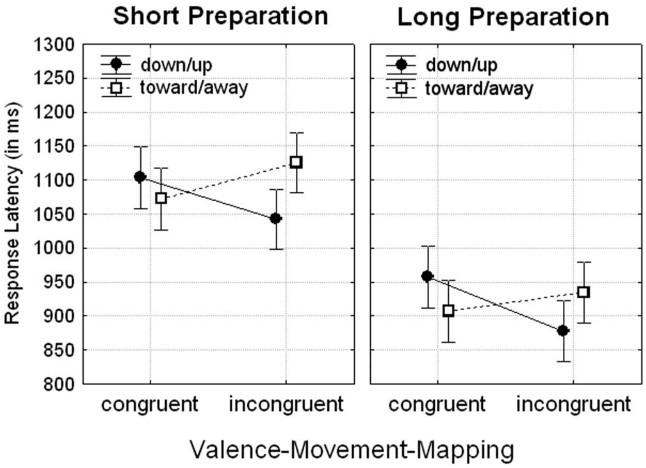

Figure 6. Mean reaction times to positive and negative words with joystick movements labeled as *towards–away* or *upward–downward* in conditions with short and long preparation of the mapping rules in Experiment 4. Congruency of the valence-movement mapping is defined along a correspondence between stimulus valence and arm movement (congruent: positive–pull/negative–push; incongruent: positive–push/negative–pull). Congruent and incongruent mapping rules were randomly varied within a block of trials. Error bars display the 0.95 confidence interval.

of S-R rule retrieval processes. This result contrasts with the prediction of the memory-retrieval account and supports the direct response activation hypothesis.

In evaluating this finding, it should be noted that the lack of an interaction effect between affective congruency and advance knowledge can be attributed neither to an inefficiency of the employed memory manipulation nor to a lack of test power. Advance knowledge of the subset of mapping rules markedly reduced response times, indicating that the long-preparation interval was efficiently used to implement the cued subset of mapping rules and reduced the memory demands for the retrieval of the correct S-R rule in a trial. Secondly, due to the large sample size, the experiment had sufficient test power to detect even a small effect, $1\text{-}\beta = .99$ for an effect size of $f^2 = .02$ (the post hoc power analysis was conducted with G*Power 3.0; Faul, Erdfelder, Lang, & Buchner, 2007).

Experiment 5

In this experiment, we wanted to put the response-activation account to a more direct test. A central assumption of the model is that affective stimuli increase the activation level of evaluatively congruent response codes that are used in movement control. This activation increment enhances the likelihood that the motor response is actually executed, which is beneficial in the congruent mapping condition but detrimental in the incongruent mapping condition. In consequence, affective congruency effects between stimulus valence and evaluative response labels should disappear if the labels become detached from the to-be-executed responses and from the motor representations that control them.

An alternative account might suggest that evaluative response labels affect processes that are unrelated to motor control. According to this account, the mere symbolic processing of evaluative labels without motor enactment might suffice to produce affective congruency effects in evaluative decision tasks.

We employed a go–no-go paradigm to test these hypotheses, using the evaluative response labels of the previous experiments (*towards* and *away*) as go signals in an evaluation task. Participants responded to the valence of positive and negative stimuli with lever movements but had to withhold the execution of the classification response until the arrival of a go signal. Presenting the labels *towards* and *away* as go signals allowed us to manipulate the affective congruency between imperative stimuli and evaluative labels independently of a correspondence between the labels and the to-be-executed responses. An additional experimental factor controlled whether the evaluative response labels were enacted with respective lever movements or not. In the evaluative-response-coding condition, the labels *towards* and *away* were enacted with respective push and pull movements (i.e., positive required a lever pull *towards* the body; negative, a lever push *away* from the body). In the neutral response coding condition, however, left and right lever movements were framed in evaluatively neutral terms (e.g., positive demanded a *right* lever movement and negative, a *left* lever movement).[5]

If response priming processes are implicated in affective-mapping effects, affective congruency effects should emerge with the enactment of the evaluative response labels (evaluative-response-coding condition) but not with neutrally framed lever movements (neutral response coding condition). Alternatively, if a mere symbolic processing of the go signals (labels) suffices to produce affective congruency effects in evaluative decision tasks, similar affective congruency effects between evaluative stimuli and go signals should be observed in both response coding conditions and independently of the required lever movements.

Method

Participants

Fifty-four students (35 women, 19 men) with normal or corrected-to-normal visual acuity volunteered for the experiment, 27 in each lever-movement task. The data set of one participant was discarded because she responded in 88%% of the no-go trials with a lever movement. Four participants were left-handed. The participants were between 19 and 28 years of age (M = 22.3 years), and all of them were fluent in German. None participated in the rating study.

Apparatus and Stimuli

Apparatus was the same as in Experiment 1. The response-imperative stimuli were 60 clearly positive ($M = 1.9$, $SD = 0.48$) and 60 clearly negative adjectives ($M = -1.9$, $SD = 0.57$) taken from a standardized word pool (Schwibbe et al., 1981; see Appendix). The subsets of positive and negative adjectives did not differ in frequency of usage and number of letters (range: 4–9), both $Fs < 1$. Go-signals were the German response-label words *HIN*

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[5] It is difficult to find neutral response labels that naturally apply to push and pull responses. Therefore, we abstained from just replacing the evaluative labels with neutral ones, and introduced left and right lever movements to prevent a recoding of the responses in evaluative terms.

(*toward*) and *WEG* (*away*). No-go signals comprised 48 strings of three consonants with no consecutive letter repetitions that were randomly constructed at the start of each experimental session. The adjectives were presented in lower case letters and the go–no-go stimuli in uppercase letters in white-on-black at the center of the computer screen.

Design and Procedure

The experiment had a 2 × 3 × 2 mixed design, the variables being, respectively, word valence: positive versus negative; go–no-go signal: *HIN* (toward) versus *WEG* (away) versus consonant string (no-go); and response coding: evaluative (toward–away) versus neutral (left–right). Participants classified positive and negative adjectives either with lever movements towards and away from the body or with left and right lever movements. A lever pull towards the body signaled a positive valence and a lever push away from the body, a negative adjective valence. The assignment of the left and right lever movements to the word valence in the neutral response coding condition was counterbalanced across participants. The classification responses had to be withheld until the presentation of a go–no-go signal. The words *toward* and *away* (go-signal) indicated the speeded execution of the prepared lever reaction; and a consonant string (no-go signal), its omission. Participants were explicitly instructed to ignore the specific meaning of the go-signal (toward vs. away). Lever movements were completely uncorrelated with the specific meaning of the go-signal and the evaluative stimulus-go signal relation.

An experimental trial started with the presentation of a fixation sign (asterisk) in the middle of the screen, followed by a brief blank interval (100 ms). Then the response-imperative adjective appeared at the center of the screen, which was cleared after 400 ms. The time interval until the arrival of the go–no-go signal was randomly varied in three stages (400 ms, 600 ms, 800 ms) with equal probability to prevent response anticipations. After this delay, the go–no-go signal was presented until response registration or until the individually adjusted response time limit was exceeded (no-go trials). The color of the go-signal changed to red to signal a time limit violation. In addition, error feedback was provided on lever movements in the wrong direction, on responses prior to the go–no-go signal presentation, and on reactions in no-go trials. The next trial started after 1,700 ms.

The experiment consisted of 120 experimental trials divided into two blocks of 60 trials. Each block comprised 48 go-trials and 12 no-go trials. With the random interspersion of no-go trials, we sought to enhance the processing of the go-signal and to prevent response selection from full completion (cf. Hommel, 1995, Exp. 1). In addition, a strict time limit was imposed upon the execution of the lever movements to maximize the sensitivity of our reaction time measure. Participants worked through two practice blocks with 60 trials each. In the first practice block, the maximum reaction time limit was set to 450 ms. The reaction time limit in the following blocks was then set according to the median value of the (correct) reaction times in the first practice block. The time limit was additionally adjusted after each block using a staircase procedure: It was increased by 30 ms if fewer than 20%% of the responses were executed correctly within the time limit, and it was decreased by 30 ms if more than 80%% of the correct reaction times were within the limit. In all blocks, the reaction time limit was constrained to a minimum of 350 ms and to a maximum of 550 ms.

Several measures were taken to prevent strategic responding to the meaning of the go-signals (toward vs. away). First, the high number of practice trials and the error feedback of wrong adjective classifications should eliminate any doubts about which stimuli were response-imperative. Second, participants were instructed to move the lever in a task-irrelevant direction (left–right in the evaluative-response-coding condition and pull–push in the neutral response coding condition) when they had missed an adjective presentation and were uncertain about the required lever response at the time of the go-signal presentation. Third, participants were rewarded for a high number of correct responses within the time limit and for correct response omissions in no-go trials with a chocolate bar in addition to the standard monetary reward (€1). With these manipulations, we made sure that participants were motivated to base their responses on the word valence and not on the specific (evaluative) meaning of the go-signal.

Results

On average participants responded erroneously with a lever reaction in 24%% ($SD = 14.1$) of the no-go trials. Only go-trials were subjected to analyses. Trials with lever movements in a task-irrelevant direction (0.3%% of all trials) or with a lever reaction prior to the go-signal (1.9%% of all trials) were discarded from all analyses. Trials with wrong valence classifications (3.0%% of all trials) and with a reaction time below 150 ms or above 1,000 ms (2.7%% of all trials) were additionally excluded from the reaction time analyses. The reaction time limit was centered at 421 ms ($SD = 50$), averaged across all participants.

An ANOVA of the mean reaction times with affective congruency between stimuli and go signals, congruent (positive–toward, negative–away) versus incongruent (positive–away, negative–toward) as the within-subjects factor and response coding, evaluative (toward–away) versus neutral (left–right) as a between-subjects factor, revealed a significant main effect of evaluative congruency, $F(1, 51) = 5.8$, $p < .05$, and a significant interaction between evaluative congruency and response coding, $F(1, 51) = 10.78$, $p < .01$. As Figure 7 illustrates, participants executed lever movements towards and away from the body faster after the presentation of an evaluatively congruent combination of stimuli and go signals ($M = 399$ ms, $SE = 7.9$) than after the presentation of an evaluatively incongruent combination ($M = 409$ ms, $SE = 8.2$), $t(25) = -3.7$, $p < .01$. The evaluative congruency relation had virtually no effect upon the response speed of left and right lever movements ($M_{congruent} = 397$ ms, $SE = 7.7$; $M_{incongruent} = 396$ ms, $SE = 8.0$), $t < 1$. The main effect of response coding was not significant, $F < 1$.

Overall, the proportion of wrong valence classifications was very low ($M = 3.0$%%, $SD = 2.3$). An ANOVA of the mean error rates (in percents) yielded neither a significant main effect of evaluative congruency ($M_{congruent} = 1.3$%%, $SE = 0.2$; $M_{incongruent} = 1.6$%%, $SE = 0.2$), $F(1, 51) = 2.60$, $p = .11$, nor a significant interaction between evaluative congruency and response coding condition, $F(1, 51) = 0.53$, $p = .47$. In addition, evaluative and neutral response codings did not differ in the proportion of wrong valence classifications, $F < 1$.

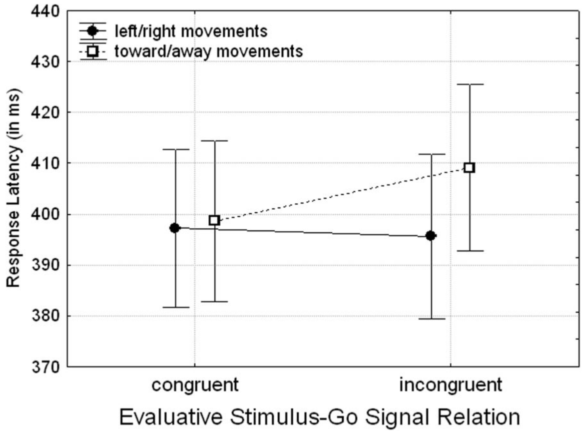

Figure 7. Mean response latencies of neutrally framed left and right lever movements and evaluatively coded push and pull movements in trials with evaluatively congruent (positive–toward, negative–away) and evaluatively incongruent (positive–away, negative–toward) stimulus-go signal combinations in Experiment 5. Error bars display the 0.95 confidence interval.

Discussion

In Experiment 5, the words *toward* and *away* were presented as go-signals in an evaluation task. In addition, the to-be-executed movement responses were either coded in evaluative (*towards* vs. *away*) or neutral (*right* vs. *left*) terms. An affective congruency effect emerged between the valence of the stimulus words and the evaluative response labels (in the evaluative response condition) but not between the stimulus valence and the valence of the go-signals (in the neutral response condition). This finding supports the assumption that affective congruency effects are located at the response selection stage: The selection requirement between differently valenced response alternatives establishes a (mis)match relation between evaluative stimulus and response codes that enables faster responses in case of an evaluative S-R match than in case of an evaluative S-R code mismatch. A mere evaluative correspondence relation between stimuli and go-signals that is unrelated to the selection of evaluatively coded responses is not sufficient to produce an affective congruency effect.

General Discussion

In a series of experiments, predictions of affective-mapping effects derived from special-muscle-activation and distance-regulation accounts were systematically pitted against an evaluative coding view of approach and avoidance reactions. Participants had to react to affective stimuli as rapidly as possible with lever reactions that were instructed either as movements *towards* and *away* or as *downwards* and *upwards* movements (see Figure 1). In line with the predictions of the evaluative coding view, standard affective-mapping effects were reversed by the use of response labels of opposite evaluative meaning. In Experiments 1 and 4, the congruency of positive and negative stimulus evaluations with a lever pull and push was defined according to an arm-bending (pull = approach) and arm-extending movement component (push = avoidance). The results replicated the standard finding of a positive–pull and a negative–push facilitation with movement instructions *towards* and *away* from the body, but this facilitation pattern was reversed when a lever pull was labeled *downwards* and when a lever push was labeled *upwards*. In Experiment 2, the congruency relation was defined according to a distance-regulation account, with a lever push to the evaluated stimulus indicating approach (distance decrease) and a lever pull away from the evaluated stimulus indicating avoidance (distance increase). Congruent with this definition, a positive–push and negative–pull facilitation was observed with instructions *towards* and *away* from the evaluated stimulus; however, this mapping effect was again reversed with lever movements labeled *downwards* and *upwards*. In Experiment 3, a congruency relation between left and right lever movements and stimulus evaluations was defined along the evaluative implications of the response labels assigned to the lever movements. The results showed comparable facilitations of *towards*- and *upwards*-instructed responses in positive evaluations and of *away*- and *downwards*-labeled movements in negative evaluations, irrespective of the physical lever movements actually performed. Accordingly, neither specific-muscle-activation patterns nor distance regulations can account for the full set of findings; instead, the results support the assumption that evaluative connotations of action labels assign the value of motor responses on a representational level that match or mismatch the valence of evaluated stimuli.

It should be noted that valence modulations of pushing and pulling (lever) movements are of standard use in research on emotion (e.g., Marsh et al., 2005), motivation (e.g., Fishbach & Shah, 2006), and social attitudes (e.g., Neumann et al., 2004) to indicate spontaneous behavioral tendencies of approach and avoidance. Yet, the results of the present experiments make clear that a unitary theoretical principle justifying this standard operationalization with lever movements is lacking to date. For example, the facilitation of a lever pull towards the body in positive evaluations and of a lever push away from the body in negative evaluations that was observed in Experiments 1 and 4 might suggest an evaluative congruency relation to arm-bending and -extending movement components. Yet this motor bias explanation is unable to account for the reversed facilitation of lever pushes toward a positively evaluated stimulus and of lever pulls away from a negatively evaluated stimulus that were observed in Experiment 2. The latter results might instead invite a distance-regulation explanation that predicts faster body movements (of the lever-moving hand) towards positive stimuli and away from negative stimuli. This latter explanation, however, is again at odds with the positive–pull/negative–push facilitation pattern observed in Experiments 1 and 4. Accordingly, neither specific muscle involvements nor distance regulations are able to integrate the reversed affective-mapping effects produced by the towards–away instruction groups in these experiments. At best a combination of both accounts is able to explain the facilitation patterns in a piecemeal fashion, but even then the observation of analogous affective-mapping effects in lever reactions to the left and right (Experiment 3) and the reversal of affective-mapping effects with up–down instructions remain unexplained. In conclusion, existing accounts of congruency relations between affective stimuli and lever pulls and pushes are unable to explain the reversed mapping effects with a change of the movement instructions only.[6]

Affective Congruency between Evaluative Stimulus and Response Codes

In the following, we outline the evaluative coding hypothesis as a unitary account of affective-mapping effects with approach and avoidance actions. The assumption of an instruction-dependent coding of evaluative action allows for an easy and parsimonious explanation of the present results. As indicated by the evaluative ratings of the response labels, *towards*- and *upwards*-instructed lever movements should be positively coded, whereas *downwards* and *away* instructions suggest a negative action coding. In consequence, response labels of opposite valence (e.g., *towards* and *downwards*) applied to physically identical lever movements (e.g., a lever pull in Experiment 1) impose an evaluative response coding of opposite valence upon these behaviors, explaining the reversed affective-mapping effects with opposite congruency relations between evaluative response codes and stimulus evaluations. In line with S-R compatibility models (Kornblum et al., 1990; Proctor & Cho, 2006), faster response selections are then expected in the case of an evaluative code match (e.g., positive–toward, negative–downward) than in the case of an evaluative code mismatch (e.g., negative–toward, positive–downward). Note that such an explanation of affective-mapping effects with a conceptual or structural S-R correspondence does not have to draw upon central motivational states to account for response facilitations in stimulus evaluations (Eder & Klauer, 2007).

In addition to explaining the present results, the evaluative coding view is also able to integrate prior findings within its framework. For example, in the study of Rotteveel and Phaf (2004), participants were instructed “to push the *upper* or *lower* button in response to a stimulus” (p. 159, italics added), and they were faster to push the upper button in positive than in negative evaluations and faster to press the lower button in negative than in positive evaluations. The authors explained this affective-mapping effect with an arm flexion in an upper button push and an arm extension in a lower button press, not taking the evaluative implications of an *upper* (positive) and *lower* (negative) button press instruction into account. However, a positive coding of an upper button press and a negative coding of a lower button press that is similar to those with *upwards* and *downwards* instructions in the present study might alternatively explain a response facilitation in matching stimulus evaluations. In another study (Markman & Brendl, 2005), participants were faster to move positive words *towards* a reference point and negative words *away* from this reference than vice versa, regardless of whether these responses required an arm-extending lever push or an arm-bending lever pull. Flexible evaluative codings of these lever movements in terms of *towards* and *away* can explain why the execution of a physically identical lever pull is facilitated in one positive evaluation context (towards-coding) and delayed in another positive evaluation context (away-coding). Accordingly, seemingly disparate findings that were explained with exclusive accounts of approach and avoidance (muscle activation vs. distance control) can be integrated within a single evaluative coding framework that ascribes affective congruency effects between stimuli and responses to an affective code (mis)match.

The present experiments show that instructions of *upwards* and *downwards* movements yield similar valence modulations of lever movements like instructions with *towards* and *away* that are more typical for research on approach and avoidance tendencies. This generality of valence modulations supports the assumption of an evaluative response coding, even though the present results cannot exclude the possibility that these codings are restricted to a few affective concepts that are particularly closely linked to positive and negative evaluations (Crawford et al., 2006; Meier & Robinson, 2004). From a theoretical perspective, we expect evaluative response codings to generalize across a broad range of valenced concepts, just as affective modulations of motor behaviors were shown across a broad range of experimental tasks and procedures.[7] For example, the execution of forward (positive) and backward (negative) coded movements or of on (positive) and off (negative) responses in an evaluative processing context should yield affective-mapping effects that are analogous to those observed with toward–away and up–down instructions. Future research should inform us whether evaluative action codings are restricted to some particular domains of conceptual representations and which concepts are particularly effective for emotional behavior control.

The Mechanics of Affective-Mapping Effects

In cognitive research, two parallel routes of response selection are typically distinguished in accounts of mapping effects (Eimer et al., 1995; Kornblum et al., 1990; Proctor & Cho, 2006; cf. Vu & Proctor, 2004): (a) automatic response activations by conceptually, structurally, or perceptually related stimulus features that are consistent with short-term, task-defined S-R associations for the compatible mapping but not for the incompatible mapping; and (b) intentional S-R translation processes that are more efficient for compatible than incompatible mappings. Such dual-route architectures of automatic and intentional response selection processes were successfully applied to the explanation of a wide array of S-R compatibility phenomena (for a review see Proctor & Vu, 2006), including affective S-R compatibility effects with relevant and irrelevant feature overlaps on the evaluative dimension (De Houwer, 2003a; Klauer & Musch, 2003; see also Strack & Deutsch, 2004).

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[6] Ambiguous operationalizations of lever pulls and pushes as behavioral approach and avoidance manifestations complicate a meaningful comparison of results across task setups that differ in the evaluative action frame. They do not, however, question the sensitivity of affective-mapping effects to evaluative subtleties within a single task that holds the evaluative response codings constant.

[7] It should be noted that instructed response labels are only accepted for action coding as long as they comply with the current task goal. From several coding possibilities, participants strive to select and weight that set of stimulus and response codes that maximizes performance on the current task most effectively. In general, internal recodings of action representations are likely (a) if the task complexity can be reduced by a reframing of mapping rules (Rothermund & Wentura, 2004; Rothermund, Wentura, & De Houwer, 2005), (b) if an alternative to the instructed response labels maps more naturally onto the requested motor behaviors (e.g., Glenberg & Kaschak, 2002), and (c) if perceptual action frames (e.g., moving the stimulus *towards* or *away* from the viewer) are more salient for action control (e.g., Rinck & Becker, 2007, Exp. 2).

In the following, we will adapt a dual-route model to account for affective-mapping effects with approach and avoidance movements and detail some of the theoretical implications for motivational and embodiment-related discussions of affective-mapping effects. Figure 8 illustrates the basic structure of a dual-route model that was adapted to account for the findings of the present experiments. One route of response selection is under intentional control, and it is this route that actually realizes the task instruction. With task instructions to move a lever *towards* and *away* (or *up* and *down*) depending on the stimulus valence, this route takes the stimulus valence as a parameter, proceeds with a search of the appropriate valence-movement mapping rule, and then activates the required motor movement. The other route is established by an evaluative correspondence relation between internal stimulus and response codes. In this route, positively (e.g., *towards*, *upwards*) and negatively (e.g., *away*, *downwards*) framed responses are directly activated by a matching stimulus evaluation.[8] Accordingly, response activations of both routes converge with a compatible mapping but diverge with an incompatible valence-movement mapping. In the latter case, a response conflict arises that delays response execution.

A specific mechanism of the intentional route was tested in Experiment 4. According to a memory-retrieval account of affective-mapping effects, response labels that correspond with the stimulus valence (e.g., positive and *up*) are more readily retrieved in the search of the assigned response than evaluatively incongruent response labels (e.g., positive and *down*). This assumption was tested with manipulations of the preparatory state of mapping rules. Results showed affective congruency effects of equal strength with advance preparation and no preparation of the mapping rules at the time of the stimulus presentations, indicating that affective-mapping effects are not mediated by an affective priming of S-R rule retrieval processes. The dual-route model attributes affective-mapping effects instead to more direct activations of evaluative coded responses by affective stimuli that bypass intentional valence-movement translation processes (see Figure 8).

Most direct evidence for automatic response activations in mapping tasks comes from electrophysiological studies that show more frequent activations of the nonrequired response in incongruent mapping conditions than in congruent mapping conditions (e.g., Hasbroucq, Burle, Akamatsu, Vidal, & Possamaï, 2001). Drawing on this research, we analogously assume direct activations of evaluative coded responses by affective stimuli. However, these spontaneous reactions to affective stimuli are assumed to be conditional upon the (instruction-dependent) top-down specification of evaluative response codings. With differently valenced response options held in high state of readiness, stimulus valence automatically triggers the response option that corresponds with the stimulus valence. The mere symbolic processing of evaluative labels without motor enactment should however not suffice to produce affective congruency effects in evaluative decision tasks. This hypothesis was tested in Experiment 5, which presented the words *toward* and *away* as go-signals in an evaluation task. One group of participants enacted the evaluative response labels with lever movements *towards* and *away* from the body, the other group responded with neutral *right* and *left* lever movements. The results showed affective congruency effects between the evaluative stimuli and the go signals with evaluatively coded responses but not with neutrally framed responses. A mere symbolic processing of the stimuli and go signals (labels) without enactment of the evaluative response labels was consequently not sufficient to produce an affective congruency effect.

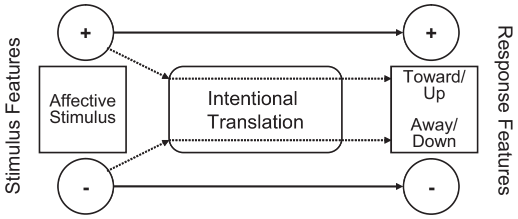

Figure 8. Basic structure of a dual-route model of affective congruency effects with differently instructed motor reactions. Intentional translation processes are represented by broken lines, automatic response priming processes by straight lines (adapted from Hommel, Proctor, & Vu, 2004, Figure 1).

The evaluative coding view also allows for an explanation of an evaluative task-goal dependency of affective-mapping effects that was observed in several experiments (Lavender & Hommel, 2007; Rotteveel & Phaf, 2004). Different action feature codes should be weighted to a different degree in task instructions and according to task requirements, resulting in higher activation states of task-relevant features than of task-irrelevant dimensions (Memelink & Hommel, 2005; Wenke & Frensch, 2005). For example, evaluative response codes of *lower* and *upper* button presses should be weighted more heavily in evaluative discriminations than in gender decisions about emotional facial expressions, explaining the absence of affective-mapping effects in the latter task condition (Rotteveel & Phaf, 2004). Accordingly, even unobtrusive evaluative connotations of response labels should gain access to response selection processes if they serve to discriminate one response alternative against the other (Ansorge & Wühr, 2004; Lavender & Hommel, 2007).

A major advantage of this theorizing is that it bridges the theoretical gap between explanations of affective congruency effects with approach and avoidance reactions and accounts of traditional affective S-R compatibility effects with binary reactions to valenced stimuli (e.g., sequential affective priming, affective Simon-task; see De Houwer, 2003a, for a structural analysis of these paradigms). According to the evaluative-response-coding view, the selection between more unobtrusively valenced approach and avoidance reactions might follow the same set of rules as the selection between clearly valenced response options in traditional affective S-R compatibility paradigms. In consequence, we view latter paradigms not only as useful to the study of indirect attitudes and automatic affect but also as useful tools for the study of automatic reactions to affective stimuli.

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[8] An evaluative S-R code match might also be experienced more fluently (Winkielman, Schwarz, Fazendeiro, & Reber, 2003), explaining more positive evaluations of positive and negative stimuli in congruent arm positions (Centerbar & Clore, 2006; Cretenet & Dru, 2004).

Implications for Motivational and Embodiment Accounts of Affective-Mapping Effects

The theoretical explanation of affective-mapping effects with an evaluative S-R code (mis)match questions the theoretical inference of motivational states from valence modulations of lever movements. In motivational explanations of affective-mapping effects, positive and negative stimulus evaluations are assumed to be directly linked to basic motivational states of approach and avoidance and, through such motivations, to specific response tendencies (Chen & Bargh, 1999; Neumann et al., 2003). Affective-mapping effects are then attributed to motivationally induced response activations that converge with intentional response selection processes in the congruent mapping but not in the incongruent mapping condition. Even though the basic structure of such a motivational account resembles the dual-route explanation sketched above, they differ in several important aspects. First and foremost, motivational explanations introduce motivational states as mediator systems between affective stimuli and responses, whereas an affective variant of a dual-route model allows for direct interactions between evaluative stimulus and response codes in the automatic route. In consequence, direct response activations by affective stimuli are more parsimoniously explained with an evaluative S-R code correspondence than with motivational systems that link affective stimuli to responses (cf. Eder & Klauer, 2007). Second, motivational accounts typically assume unconditional links between evaluation and behavior that operate outside and independently of intentional control settings. The evaluative-response-coding view, however, assumes direct response activations to be dependent upon the top-down specification of evaluative response codings and upon an intentional weighting of affective stimulus and response codes. Third, motivational accounts allow only for automatic activations of responses that are functionally related (e.g., distance regulation) or long-term associated (e.g., arm flexion and extension) with motivational orientations of approach and avoidance. The evaluative-response-coding view, on the other hand, expects affective response activations with any motor behavior that relies on evaluative response codes. In sum, there exist a number of important differences between motivational accounts of affective-mapping effects and the evaluative-response-coding view that lead to different predictions regarding the conditions and the generality of automatic responses towards affective stimuli.

The evaluative-response-coding view attributes affective-mapping effects to a correspondence relation between evaluative stimuli and response features on a cognitive, representational level and not to interactions on the motor level. Such a cognitive response coding view has several advantages: First, it is able to accommodate the present and other findings that showed an influence of perceptual and instructional action frames on affective-mapping effects despite the execution of physically identical motor movements (e.g., De Houwer et al., 2001; Markman & Brendl, 2005). Second, it parsimoniously integrates a large and diverse set of empirical studies that observed affective congruency effects with very different motor behaviors. Third, it connects to broader cognitive research that showed that S-R compatibility effects are dependent upon a referential and intentional coding of response properties and not upon anatomical response properties (e.g., Hommel, 1993; Wallace, 1971). In sum, affective-mapping effects are located in flexible specifications of evaluative stimulus and response properties that take task demands and situational constraints into account. In consequence, this coding view is at odds with theoretical accounts that explain affective congruency effects with hard-wired, rigid connections between evaluations and instrumental motor responses (e.g., the Hard Interface Theory of Zajonc & Marcus, 1985). In addition, it is also opposed to assumptions of more recent embodiment discussions of affective-mapping effects that ascribe these effects to a retrieval of stored response tendencies on a cognitive processing level (Niedenthal, 2007; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; see Markman & Brendl, 2005, for a similar argument). According to embodiment views, conceptual representations are grounded in concrete sensory-motor experiences that are reinstated in symbolic concept activations (e.g., Barsalou, 2002; Glenberg & Kaschak, 2002). Adopting such an embodiment view, Niedenthal and colleagues explained affective-mapping effects with reenactments (or simulations, in Barsalou's terms) of long-term associated motor tendencies in the conceptual processing of affective stimuli that could either match or mismatch the required response defined by the task instructions. Importantly, these concept simulations are assumed to differ with variations in the task setting, introducing some flexibility to the link between valence and specific bodily movements. For example, people might simulate affective reactions to valenced symbols in deep processing conditions like evaluative word decisions but not in processing tasks that allow for a shallow processing strategy. In addition, people might conceptualize valenced categories differently across situations, preparing perhaps different action courses in each simulated situation. For example, simulating an arm extension in a greeting hand-shake might be compatible with positive stimuli, but simulating the same response as a rude shove might be congruent with negatively valenced stimuli. Accordingly, the embodiment view agrees with the evaluative coding framework on the importance of contextualized, situated representations for the explanation of affective-mapping effects. They differ, however, in their theorizing about the origins of a valence-movement compatibility. Whereas an embodiment account attributes affective-mapping effects to reenactments of previous affective motor responses in concept simulations, the evaluative coding framework explains them with a much more flexible assignment of positively and negatively valenced action concepts to motor representations. In fact, it is difficult to see why simulations of identical adjective words (see Appendix) should go along with opposing response tendencies after changing only the labels of the required lever movements (*towards–away* vs. *up–down*), as it was observed in the present experiments. In sum, even though the evaluative coding framework and embodiment-related discussions of affective-mapping effects agree on a number of important assumptions (e.g., contextualized, modality-specific response representations), they differ in their theorizing about the exact mechanisms that give rise to a compatibility relation between affective stimuli and motor responses.

Redefining Approach and Avoidance Reactions

In this article, an evaluative coding view of motor behavior was described that conceptualizes approach and avoidance reactions as positively and negatively coded motor behaviors: Evaluative implications of semantic action labels and action goals are hypothesized to assign affective codes to motor responses on a representational level that could either match or mismatch the valence of stimuli reacted to. Response facilitations are then expected in case of an evaluative S-R match rather than in case of an evaluative S-R mismatch.

With its general notion of a representational match between stimulus and response codings, the evaluative coding view is able to integrate a large and diverse set of findings that were taken to defend more specialized accounts of approach and avoidance behaviors emphasizing certain biological functions (e.g., consumption, protection), specific muscle activations (e.g., arm flexion and extension), or distance regulations to the evaluated object (e.g., approach and withdrawal). In addition, the coding framework allowed for predictions of affective-mapping effects that were supported by neither of these specialized accounts. In sum, the evaluative coding view offers a consistent and general definition of approach and avoidance actions in terms of valenced motor codings that is applicable to a diverse and large set of empirical findings. Our account, however, is not meant to dismiss the more specialized accounts, because distance regulations and biological functions may well inform us why people code behaviors in a certain way in a specific situation. Furthermore, researchers might arbitrarily decide to reserve the term *approach* and *avoidance* for certain classes of motor actions, ignoring other forms of valenced motor output. Whatever the outcome may be, we hope that the evaluative coding framework will stimulate a more explicit discussion of approach and avoidance definitions across different research strands in this field.

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Appendix

Word Materials

Experiments 1 to 4

Positive words. angenehm (comfortable), besonnen (canny), entspannt (relaxed), findig (resourceful), freimütig (frank), friedlich (peaceful), gefällig (complaisant), gemütlich (comfortable), gesund (healthy), großmütig (noble), gütig (benevolent), herzlich (cordial), human (humane), korrekt (accurate), liebevoll (affectionate), loyal (loyal), musisch (musical), nett (nice), reinlich (tidy), sachlich (objective), sonnig (sunny), taktvoll (tactful), treu (trusty), zärtlich (caressing).

Negative words. aggressiv (aggressive), anmaβend (presumptuous), böse (evil), boshaft (malicious), brutal (brutal), eitel (vain), furchtbar (dreadful), gefühllos (deadhearted), giftig (noxious), herrisch (bossy), hochnäsig (snobbish), jähzornig (irascible), kaputt (broken), knauserig (miserly), lästig (annoying), launisch (capricious), peinlich (embarrassing), rüpelhaft (boorish), schlecht (bad), schuldig (guilty), starr (rigid), tödlich (deathly), traurig (sad), zynisch (cynical).

Experiment 5

Positive words. achtsam (attentive), angenehm (comfortable), anziehend (appealing), befähigt (competent), begabt (talented), belesen (literate), beliebt (popular), charmant (charming), dankbar (thankful), denkfähig (cogitative), ehrlich (honest), engagiert (committed), fair (fair), findig (resourceful), fleißig (diligent), flexibel (flexible), freimütig (frank), freudig (joyful), friedlich (peaceful), fröhlich (happy), gebildet (educated), geduldig (patient), gefällig (complaisant), geistvoll (brilliant), gelassen (calm), gelehrig (teachable), gemütlich (comfortable), gerecht (just), gesittet (civilized), gewitzt (shrewd), groβmütig (noble), grundgut (thoroughly good), gütig (benevolent), herzlich (cordial), human (humane), korrekt (accurate), kreativ (creative), liebevoll (affectionate), loyal (loyal), milde (benignant), musisch (musical), nett (nice), optimal (ideal), originell (fancy), praktisch (covenient), redlich (candid), reinlich (tidy), sachlich (objective), sanft (gentle), sensibel (sensitive), sonnig (sunny), sorgsam (careful), standhaft (firm), taktvoll (tactful), tolerant (tolerant), treu (trusty), vergnügt (cheery), witzig (witty), zart (tender), zärtlich (caressing).

Negative words. abhängig (addicted), abweisend (abrasive), aggressiv (aggressive), anmaßend (presumptuous), arglistig (dissembling), barsch (harsh), beklommen (apprehensive), bockig (recalcitrant), bösartig (malignant), böse (evil), boshaft (malicious), brutal (brutal), dumm (stupid), eitel (vain), entmutigt (crestfallen), fanatisch (fanatic), furchtbar (dreadful), gefühllos (deadhearted), gehässig (spiteful), geizig (stingy), gemein (nasty), gierig (greedy), giftig (noxious), grausam (atrocious), grimmig (grim), habgierig (possessive), herrisch (bossy), herzlos (heartless), hochmütig (arrogant), hochnäsig (snobbish), jähzornig (irascible), kalt (cold), kaputt (broken), knauserig (miserly), korrupt (corrupt), kühl (chilly), langsam (tardy), lästig (annoying), launisch (capricious), lieblos (loveless), monoton (monotonous), neidisch (envious), nervös (nervous), peinlich (embarrassing), penibel (fussy), rüde (rude), schlampig (sloppy), schlecht (bad), schmutzig (filthy), schuldig (guilty), starr (rigid), teuer (expensive), tödlich (deathly), träge (sluggish), traurig (sad), untertan (tributary), verbissen (stubborn), verlogen (dishonest), zänkisch (quarrelsome), zynisch (cynical).

Received March 16, 2007
Revision received November 8, 2007
Accepted November 14, 2007 ■